

What is claimed is:

1. A workshop facility designing and operating method which comprises a virtual workshop verifying process of formulating a virtual workshop that is a data model of an existing or newly established workshop having a portion or the whole that is newly designed and for verifying a production state by means of a simulating means by causing the virtual workshop to perform a quasi-production activity; a workshop deployment process of constructing an actual workshop utilizing a data model of the virtual workshop so verified, and a remote monitoring process of remote monitoring the actual workshop so constructed and comparing a result of remote monitoring and the verification performed during the virtual workshop verifying process.

2. A workshop facility designing and operating method which comprises a virtual workshop verifying process of formulating a virtual workshop that is a data model of an existing or newly established workshop having a portion or the whole that is newly designed, functions of a manufacturing facility or process step and a physical distributing facility of process step and information on a layout of these facilities and for verifying a production state and a physical distribution state on the layout by means of a simulating means by causing the virtual workshop to perform a quasi-production activity; a workshop deployment process of constructing an actual workshop utilizing the facilities and the layout in the data model of the virtual workshop so verified, and a remote monitoring process of remote monitoring the production state and the physical distribution state of the facilities in the layout employed in the actual workshop so constructed and comparing a result of remote monitoring and the verification performed during the virtual workshop verifying process.

3. The workshop facility designing and operating method as claimed in Claim 2, wherein the virtual workshop includes a plurality of virtual facilities, which are models of individual facilities, and wherein the simulating means has a facility simulating section for verifying each of the virtual facilities and an

overall simulating section for unifying results of verification of the individual facilities performed by the facility simulating section to thereby apply them to the layout.

4. The workshop facility designing and operating method as claimed in Claim 3, wherein the facility simulating section for the virtual facilities of a production facility is capable of setting an operating condition and an adjusting condition settable of the production facility and also capable of verifying appropriate to the operating condition and the adjusting condition that has been set.

5. The workshop facility designing and operating method as claimed in Claim 1, wherein during the verifying process performed by the simulating means a quality of a product being produced is one of items that are to be verified.

6. The workshop facility designing and operating method as claimed in Claim 1, wherein the facility simulating section is capable of performing verification by causing a program for executing procedures of operating the production facility to be quasi-executed.

7. The workshop facility designing and operating method as claimed in Claim 1, wherein the simulating means is capable of performing verification corresponding to change in process step resulting from change in morphology of the facility of the workshop.

8. The workshop facility designing and operating method as claimed in Claim 1, wherein the plural production facilities are a dedicated unitary equipment in which modular units are interchangeably fitted one at a time to a common process machine and the simulating means is capable of performing verification corresponding to change of the modular units.

9. The workshop facility designing and operating method as claimed in Claim 1, wherein during the virtual workshop verifying process verification

according to an operating calendar condition and verification corresponding to an abnormality occurring in the facility are carried out.

10. The workshop facility designing and operating method as claimed in Claim 4, wherein during the workshop deployment process, information on operating conditions set during the virtual workshop verifying process is transmitted as an instruction through a data communication means to the production facility and a production step.

11. The workshop facility designing and operating method as claimed in Claim 1, wherein during the remote monitoring process a remote maintenance of the facility is performed with use of a result of monitoring.

12. The workshop facility designing and operating method as claimed in Claim 11, wherein if there is a difference between the result of monitoring and the result of verification, the simulating means verifies the production state by causing the virtual workshop to perform a quasi-production activity again and the remote maintenance is carried out according to the result of verification.

13. A workshop facility design and operation support system, which comprises:

a virtual workshop system including a virtual workshop authoring means for authoring a virtual workshop that is a model constructed according to layout information on functions of various production facilities and physical distribution facilities of a workshop, and a simulating means for verifying a production state and a physical distribution state on the layout by causing the virtual workshop to perform a quasi-production activity; and

a remote monitoring means for remote monitoring the production state and the physical distribution state of the facilities in the layout employed in an actual workshop constructed according to the model of the virtual workshop so verified.

14. The workshop facility design and operation support system as claimed in Claim 13, wherein the virtual workshop system is connected with a facility database registered therein information associated with the facility and

the virtual workshop authoring means authors the virtual workshop according to information acquired from the facility database.

15. The workshop facility design and operation support system as claimed in Claim 13, further comprising a link means for performing a link process between the virtual workshop system and a remote monitoring system.

16. The workshop facility design and operation support system as claimed in Claim 13, wherein a product to be manufactured in the workshop is a mechanical component having a rolling element.

17. A virtual workshop system which is a system for verifying a workshop wherein a plurality of production facilities are a dedicated unitary equipment having modular units that can be interchangeably fitted one at a time to a process machine of a common specification, which system comprises:

a virtual workshop authoring means for authoring a virtual workshop that is a data model of a workshop, and a simulating means for verifying at least a production state and a physical distribution state by causing the virtual workshop so authored to perform a quasi-production activity, wherein the simulating means is capable of verifying the production state and the physical distribution state when the modular units of the production facility are changed.

18. A virtual workshop system which is a system for verifying a workshop wherein a plurality of production facilities are a dedicated unitary equipment having modular units that can be interchangeably fitted one at a time to a process machine of a common specification, while some of production facilities are arranged in a plural number to define a production line, which system comprises:

a virtual workshop authoring means for authoring a virtual workshop that is a data model constructed based on information on functions of various production facilities and physical distribution facilities of the workshop and an layout of those facilities, and a simulating means for verifying a production state and a physical distribution state on the layout by causing the virtual workshop so

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authored to perform a quasi-production activity, wherein the simulating means is capable of performing verification corresponding to various changes in a production line including exchange of modular units of the production facility.

19. The virtual workshop system as claimed in Claim 17, wherein the virtual workshop authoring means is capable of authoring a model of the dedicated unitary equipment in which the modular units are changed, in reference to information on the process machine of the production facility registered in a facility database and information on the modular units.

20. The virtual workshop system as claimed in Claim 18, wherein the virtual workshop includes a plurality of virtual facilities that are models of the individual facilities, and wherein the simulating means includes a facility simulating section for verifying the virtual facilities and an overall simulating means for unifying results of verification of the individual facilities performed by the facility simulating section to thereby apply them to the layout.

21. The virtual workshop system as claimed in Claim 20, wherein the facility simulating section for the virtual facilities of a production facility is capable of setting an operating condition and an adjusting condition settable of the production facility and also capable of verifying appropriate to the operating condition and the adjusting condition that has been set.

22. A virtual workshop-remote monitoring link system which comprises a virtual workshop system as defined in Claim 17, a remote monitoring system for remote monitoring an actual workshop corresponding to this virtual workshop, and a link means for performing a linking process between the virtual workshop system and the remote monitoring system, wherein the remote monitoring system is capable of performing a remote maintenance.

23. The virtual workshop-remote monitoring link system as claimed in Claim 22, wherein the remote monitoring system is capable of interactively performing a remote monitoring and a remote maintenance, capable of displaying an image of an operator at a workshop side and alphanumeric information to be

used for monitoring or remote maintenance in side-by-side fashion and also capable of transmitting with voice.

24. The virtual workshop system as claimed in Claim 17, wherein a product to be manufactured in the workshop is a mechanical component having a rolling element.

25. The workshop facility design and operation support system as claimed in Claim 22, wherein a product to be manufactured in the workshop is a mechanical component having a rolling element.

26. A workshop-verifying system complex comprising an actual workshop and a virtual workshop system,

wherein the actual workshop includes a production line defined by production facilities and physical distribution facilities, a plurality of production facilities form respective line constituent elements, each facility being a dedicated unitary equipment in which modular units are interchangeably fitted one at a time to a common process machine, and

wherein the virtual workshop system is a virtual workshop system as defined in Claim 17.

27. A production line comprising a plurality of production facilities and a plurality of physical distribution facilities, the plural production facilities form respective line constituent elements, each facility being a dedicated unitary equipment in which modular units are interchangeably fitted one at a time to a common process machine, and a process step can be changed by changing the modular units of the production facilities.

28. The production line as claimed in Claim 27, wherein the common process machine in the dedicated unitary equipment includes a common bed and a common unit.

29. The production line as claimed in Claim 27, wherein a production machine comprising the dedicated unitary equipment comprises a grinding machine.

30. The production line as claimed in Claim 27, wherein the common process machine in the grinding machine comprises a bed, a main shaft support, a main shaft spindle and slide table capable of advancing and retracting in two axial directions perpendicular to each other, wherein a modular unit of a grindstone spindle is mounted on the slide table.

31. The production line as claimed in Claim 27, wherein the production facility comprising the dedicated unitary equipment comprises a grinding machine for grinding a bearing ring in a rolling bearing assembly, said production facility having a morphology capable of changing into one of a dedicated machine for grinding an inner peripheral surface of an inner race, a dedicated machine for grinding a raceway groove of the inner race, and a dedicated machine for grinding a raceway groove of an outer race by changing a modular unit.

32. The production line as claimed in Claim 27, wherein the common process machine in the dedicated unitary equipment includes common loading units.

33. The production line as claimed in Claim 27, wherein as one of the modular unit, there is a spindle device unit, said spindle device unit being of a built-in motor type.

34. A method of changing a process step in a production line comprising a plurality of production facilities and a plurality of physical distribution facilities, wherein the plural production facilities form respective line constituent elements, each facility being a dedicated unitary equipment in which modular units are interchangeably fitted one at a time to a process machine of a common specification, a process step being changed by changing one of the modular units of the production facilities.

35. The production line process step changing method as claimed in Claim 34, wherein the production line at a plurality of workshops is such that the plural production facilities form respective the line constituent elements, each

facility being a dedicated unitary equipment in which modular units are interchangeably fitted one at a time to a process machine of a common specification, a process step being changed by changing one of the modular units of the production facilities.

36. A large area workshop production management system which comprises a united virtual workshop system including a plurality of virtual workshop systems unified together, said plural virtual workshop systems corresponding to respective actual workshops at various places, a united remote monitoring system for remote monitoring a production record of each of the actual workshop at the various places, a collective order control and management system for controlling and managing order information at various business establishments, a physical distribution controlling and monitoring system for controlling and monitoring physical distribution state at the various places, and a production planning means;

wherein each of the virtual workshop system is comprised of a simulating means for verifying a production state by causing the virtual workshop, that is a data model of the actual workshop, to perform a quasi-production activity, and

wherein the production planning means is operable to formulate a production plan to be shared by the actual workshops, according to information acquired from the united virtual workshop system, the united remote monitoring system, the collective order control and management system and the physical distribution controlling and monitoring system and also operable to give a production instruction to each of the actual workshop based on the production plan so formulated.

37. The large area workshop production management system as claimed in Claim 36, wherein the production planning means is operable to cause the united virtual workshop system to perform verification based on information acquired from the united remote monitoring system, the order control and management system and the physical distribution controlling and monitoring

system and also operable to automatically formulate a production plan to be shared by the workshops according to a result of such verification.

38. The large area workshop production management system as claimed in Claim 36, wherein some of the actual workshops at the various places have a capability of changing a process step and the united virtual workshop system is capable of verifying a production state when the process step is changed.

39. The large area workshop production management system as claimed in Claim 36, wherein some of the actual workshops at the various places is provided with, as production facilities, dedicated unitary equipments in which modular units are interchangeably fitted one at a time to a process machine of a common specification, and wherein the united virtual workshop system is capable of verifying a production state when the process step is changed as a result of change of the modular units of the actual workshops.

40. The virtual workshop system as claimed in Claim 39, wherein the virtual workshop system includes a virtual workshop authoring means capable of authoring a mode of various dedicated unitary equipments in which modular units are changed, in reference to information on the process machine of the production facility registered in a facility controlling database and information on the modular units.

41. The large area workshop production management system as claimed in Claim 36, wherein the production planning means is capable of formulating a production plan according to a predetermined standard, with respect to predefined items including a production cost, a physical distribution, a material, a tax and so on.

42. The large area workshop production management system as claimed in Claim 36, wherein the united remote monitoring system is capable of acquiring information on at least a production record, a state of products in process, a stock of component parts available and a working state of the actual workshop.

43. The large area workshop production management system as claimed in Claim 36, wherein the production planning means is capable of transmitting a processing technique support information such as information on processing conditions or address information of storage area of a database in which processing conditions are registered and others, together with the production instruction.

44. The large area workshop production management system as claimed in Claim 36, wherein the united remote monitoring system has a function of performing a remote maintenance.

45. The large area workshop production management system as claimed in Claim 36, further comprising a facility controlling database in which information on facilities and process steps in various actual workshops subject to a production plan, information on management, operating procedures and unique information on individual facilities are registered.

46. The large area workshop production management system as claimed in Claim 36, wherein the production planning means is capable of performing an automatic repairing by which, in the event of an occurrence of a trouble in one of the facilities, a process step in the production line and the operating procedures of the production facilities can be changed through the united remote monitoring system so that a delay caused in such facility can be compensated for others of the facilities.

47. The large area workshop production management system as claimed in Claim 36, wherein the production planning means has a function of monitoring a progress of the production activity through the united remote monitoring system and automatically adjusting a line tact of the production line.

48. The large area workshop production management system as claimed in Claim 36, wherein a product to be manufactured in the workshop is a mechanical component having a rolling element.

49. A unified production management large area workshop facility comprising actual workshops at various places, a large area workshop production management system for performing a production management of those actual workshops, and a communication network means for communicating between the actual workshops and the large area workshop production management system,

wherein the large area workshop production management system is a large area workshop management system as defined in Claim 36, and wherein each of the actual workshops includes means for transmitting information on at least a production record to a united remote monitoring system in the large area workshop production management system.

50. The unified production management large area workshop facility as claimed in Claim 49, wherein the actual workshop include monitoring sensors for securing monitoring information on at least a working state of a facility within the workshop and means for transmitting the monitoring information, acquired from the monitoring sensors, to the large area workshop production management system through the communication network means.

51. The unified production management large area workshop facility as claimed in Claim 49, wherein the large area workshop production management system is a large area workshop management system as defined in Claim 39, and wherein some of the actual workshops at the various places is provided with, as production facilities, dedicated unitary equipments in which modular units are interchangeably fitted one at a time to a process machine of a common specification, and wherein the united virtual workshop system is capable of verifying a production state when the process step is changed as a result of change of the modular units of the actual workshops.